

[0036] What is claimed as new and desired to be protected by Letters Patent of the United States is:

1. A micro-lens for use in an imager, comprising:
a substrate having a recessed area; and
lens material located within the recessed area of the substrate which serves as a mold for the lens material.
2. The micro-lens of claim 1, wherein the recessed area has at least one arcuate portion.
3. The micro-lens of claim 1, wherein the recessed area is shaped such that said lens material corrects for optical aberrations.
4. The micro-lens of claim 1, wherein the substrate comprises silicon dioxide.
5. The micro-lens of claim 4, wherein said substrate is positioned over a pixel cell and the recessed area is configured to account for color dependent photon absorption differences of a photosensor of said pixel cell.
6. The micro-lens of claim 1, wherein the lens material exhibits a refractive index greater than that of the substrate.

7. The micro-lens of claim 1, wherein the lens material exhibits a refractive index less than the substrate.

8. A micro-lens, comprising:
a substrate having a recessed area, said substrate being formed of silicon dioxide; and

lens material located within the recessed area of the substrate which serves as a mold for the lens material, wherein the recessed area is shaped such that said lens material corrects for optical aberrations.

9. The micro-lens of claim 8, wherein the recessed area is configured to account for color dependent photon absorption differences in the silicon dioxide.

10. The micro-lens of claim 8, wherein the lens material exhibits a refractive index greater than that of the substrate.

11. The micro-lens of claim 8, wherein the lens material exhibits a refractive index less than that of the substrate.

12. An imager, comprising:
a plurality of pixel cells each having a photosensor;
a plurality of color filters respectively associated with said pixel cells; and
a micro-lens array including a plurality of micro-lenses each associated with

one of said pixel cells, wherein said micro-lens array effects a change in focal point between said micro-lenses to correct for optical aberrations.

13. The imager of claim 12, further comprising a light shield for directing electromagnetic radiation to each photosensor.

14. The imager of claim 12, wherein the micro-lens array includes at least one non-symmetrical micro-lens.

15. The imager of claim 12, wherein the micro-lens array includes at least one non-spherical micro-lens.

16. The imager of claim 12, comprising a CMOS imager.

17. The imager of claim 12, wherein each of the micro-lenses is formed in a substrate and comprises a lens material exhibiting a refractive index greater than that of the substrate.

18. The imager of claim 12, wherein each of the micro-lenses is formed in a substrate and comprises a lens material exhibiting a refractive index less than the substrate.

19. The imager of claim 12, wherein the plurality of color filters includes at least a first filter for a first color and a second filter for a second color.

20. The imager of claim 19, wherein said plurality of micro-lenses includes at least a first micro-lens associated with the first filter and a second micro-lens associated with the second filter, said first and second micro-lenses each being configured to account for optical aberrations in the light directed through the first and second filters.

21. A CMOS imager, comprising:

- a plurality of pixel cells each having a photosensor;
- a light shield for directing electromagnetic radiation to each photosensor;
- a color filter assembly providing respective color filters for said plurality of pixel cells;
- a substrate; and
- a plurality of lens structures respectively associated with said pixel cells for focusing light on respective photosensors, each said lens structure comprising lens material located within a recessed area of the substrate which serves as a mold for the lens material.

22. The CMOS imager of claim 21, wherein the recessed area has at least one arcuate portion.

23. The CMOS imager of claim 21, wherein the recessed area is shaped such that said lens material corrects for optical aberrations.

24. The CMOS imager of claim 21, wherein the substrate comprises silicon.
25. The CMOS imager of claim 21, wherein the recessed area is configured to account for color dependent photon absorption of the photosensors of the pixel cells.
26. A micro-lens system, comprising:
 - a first micro-lens array including a first plurality of micro-lenses;
 - a second micro-lens array including a second plurality of micro-lenses;
 - wherein the first micro-lens array is stacked above the second micro-lens array.
27. The micro-lens system of claim 26, wherein each of the first plurality of micro-lenses is above a corresponding one of the second plurality of micro-lenses.
28. The micro-lens system of claim 26, wherein the first and second micro-lens arrays are configured so as to correct for chromatic aberrations.
29. The micro-lens system of claim 26, wherein at least one of the first and second micro-lens arrays are formed in a substrate.
30. The micro-lens system of claim 28, wherein both of the first and second micro-lens arrays are formed in a substrate.

31. The micro-lens system of claim 26, wherein the index of refraction exhibited by the first plurality of micro-lenses differs from the index of refraction exhibited by the second plurality of micro-lenses.

32. The micro-lens system of claim 26, wherein the first micro-lens array comprises spherical micro-lenses.

4

33. A method for manufacturing a micro-lens array, comprising:
forming a recessed area in a substrate, wherein said recessed area includes a plurality of micro-lens sections having different profiles; and
filling the recessed area with a lens material to form a plurality of micro-lenses.

34. The method of claim 33, wherein said act of filling the recessed area comprises filling the recessed area with a lens material exhibiting a refractive index different than the refractive index of the substrate.

35. The method of claim 33, wherein the act of forming comprises coating a layer of photo resist material on the substrate.

36. The method of claim 33, wherein the act of forming comprises removing exposed portions of the layer of photo resist material.

37. The method of claim 33, wherein the act of forming comprises removing unexposed portions of the layer of photo resist material.

38. The method of claim 33, wherein said act of forming a recessed area comprises:

forming a layer of photo resist material on the substrate;
imaging the layer of photo resist material through a mask having a plurality of differently sized openings;
removing portions of the layer of photo resist material; and
etching the substrate through the portions of the layer of photo resist material to form the recessed area in the substrate.

39. The method of claim 38, wherein the act of etching comprises depositing an etching material in the portions of the layer of photo resist material to form holes in the substrate, the holes growing in size to combine to form the mold.

40. The method of claim 39, wherein the etching material comprises an at least partially isotropic etching material.

41. The method of claim 39, wherein the etching material comprises a wet etching material.

42. The method of claim 39, wherein the etching material comprises a dry etching material.

43. The method of claim 39, wherein the etching material comprises a combination of a wet etching material and a dry etching material.
44. The method of claim 33, wherein the act of filling comprises filling the mold with a lens material exhibiting a refractive index greater than the refractive index of the substrate.
45. The method of claim 33, wherein the act of filling comprises filling the mold with a lens material exhibiting a refractive index less than the refractive index of the substrate.
46. The method of claim 45, wherein the act of filling comprises filling the recessed area with a lens material comprising a polymer.
47. The method of claim 46, further comprising heating the lens material to promote thermal decomposition of the polymer.
48. The method of claim 33, further comprising connecting a color filter assembly to the substrate.